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Mapping Hydration with the Mars Exploration Rover (MER) Pancam Instruments: Recent Results from Opportunity at Endeavour Crater

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Using the Mars Exploration Rover (MER) Panoramic Camera (Pancam) instruments, we have developed a "hydration signature" for mapping H_2O- and/or OH-bearing materials at Mars landing sites with multispectral visible to near-infrared (Vis-NIR) images. Pancam's 13 narrowband geology filters cover 11 unique wavelengths in the visible and near infrared (434 to 1009 nm) [1-2]. The hydration signature is based on a negative slope from 934 to 1009 nm [3] that characterizes the spectra of hydrated silica-rich rocks and soils observed by MER Spirit; this feature is likely due to the $2\nu 1 + \nu 3$ H_2O combination band and/or the 3νOH overtone centered near $\sim$1000 nm, whose positions vary slightly depending on bonding to nearest-neighbor atoms [4]. The hydration signature is sensitive to many - but not all - hydrated minerals, including silica, gypsum and water ice. At Gusev Crater, the hydration signature is widespread along Spirit's traverse in the Columbia Hills, which adds to the growing body of evidence that aqueous alteration has played a significant role in the complex geologic history of this site [4]. At Meridiani Planum, the hydration signature is associated with a specific stratigraphic layer ("Smith") exposed within the walls of Victoria Crater [5], in addition to light-toned veins composed of calcium sulfate at Cape York on the rim of Endeavour Crater [6].

Recently, Opportunity has completed a traverse loop at Matijevic Hill at the southern end of Cape York and has encountered numerous small, light-toned, fracture-filling veins that may be indicative of fluid flow. Spectra of these veins are also consistent with hydrated materials, as are spectra of "Whitewater Lake" outcrops at Matijevic Hill, which may contain phyllosilicate minerals [7-8]. Here we also discuss limitations to the use of the hydration signature, which can give false detections under specific viewing geometries. For example, the Pancam calibration model assumes that the calibration target behaves as a Lambertian scatterer, an assumption that, for the specific calibration target materials used on the rovers, is increasingly incorrect as incidence angles get closer to 90° or at strongly forward scattering geometries [2]. We have a acquired a series of Pancam observations at the Whitewater Lake outcrop at varying incidence and emission angles to quantify the effects of phase angle on the 934 to 1009 nm spectral slope that defines the hydration signature. These results will allow for more robust hydration detections and better estimates of relative hydrated mineral abundances in future Pancam observations.

[1] J.F. Bell III et al. (2003) JGR, v108, E12; [2] J.F. Bell III et al. (2006) JGR, v111, E02S03; [3] A. Wang et al. (2008) JGR, v113, E12; [4] M.S. Rice et al. (2010) Icarus, v205, 375; [5] R.E. Arvidson et al. (2011) JGR, v116, E7; [6] S.W. Squyres et al. (2012) Science, v336, 6081; [7] S.W. Squyres et al. (2013) LPSC 44th; [8] R.E. Arvidson et al. (2013) LPSC 44th.